As slips 54 in lower head H_2 are raised to release their grip on the drill pipe, the associated cam sleeve 81, being attached to lift ring 57, will be moved upward relative to lower housing 23, 23*a*. Teeth 42 of shoes 38 in the lower head H_2 will still be in engagement with the drill pipe. However, by reason of this engagement, initial angular movement by the upper snubbing head will be transmitted through the drill pipe to cam plate 35 in the lower snubbing head causing the cam plate to rotate retractor cams 45 into engagement with the roller carrying ends of the related shaft 40 (FIG. 10) to effect positive retraction of shoes 38 from engagement with pipe P thereby freeing the pipe for rotation by the upper snubbing head.

When the end of a drilling stroke is reached, and it is necessary to add a new section of drill pipe, the slips in the lower head will be set below the drill pipe box B, in the position as seen in FIG. 2 and the mud line connection to the upper end of the drill pipe will be released. Thereupon the upper set of slips will be raised and released and the upper snubbing head raised to receive the new section of drill pipe which will be lowered through the bore of the upper snubbing head and its threaded pin stabbed into the box member of a coupling C. Thereupon, the upper slips will be lowered and set and right-hand rotation of the upper head begun while the slips in the lower head remain in gripping position to serve as a back-up wrench while the threading operation takes place. Some pressure fluid may be released from jacks J to accomodate the downward movement of the upper head as the threads are made up. The setting of the upper slips and the initial rotation of the upper head will act through upper cams 43 to move upper shoes 38 into torque-applying engagement with the pipe.

This sequence of operations as heretofore described is repeated as the drilling proceeds to continue the addition of sections of pipe to the drilling string to correspond to the increased well depth.

FIG. 2 also illustrates the relative positions of the snubbing heads at a stage in the process of breaking down the pipe string, as when withdrawing it from the well for changing bit or other purposes requiring removal of the pipe from the well. As shown, both sets of slips 54 and torque shoes 38 will be set to grip the pipe on opposite sides of coupling C. Thereupon, upper head H_1 may be rotated in the direction to unscrew the upper section of the pipe string while the lower head H_2 holds back against the lower pipe section. Pressure fluid will be applied to jacks J to raise upper head H_1 sufficiently to accommodate the unthreading operation. The upper slips may then be released to allow the now unthreaded pipe section to be withdrawn from the upper head.

The upper head will then be lowered about the upper end of the pipe section left projecting above the lower head and the upper slips will again be set; the lower slips released and the pipe string raised to bring the next coupling up above the lower head in position for repetition of the previously described unscrewing of the thus elevated pipe section.

Elevation of cam sleeves 81 with their respective lift rings 57 in effecting release of the related slips 54 will produce camming action between cam surfaces 83 and rollers 85 to produce the limited relative angular movement of cam plate 35 required to cause retractor cams 45, by acting against the ends of shafts 40, to effect retraction of shoes 38 sufficient to retract teeth 42 from engagement with pipe P. This provides assurance that any time slips 54 are released, the torsion-applying teeth 42 also will be positively released.

The well drilling apparatus heretofore described provides a highly efficient, low-cost, rotary drilling unit capable of drilling to depths of 10,000 feet or more by reason of the fact that the entire load of the drilling string in drilling and in running the pipe in and out of the well is carried on hydraulic jacks. Thus, only a light load capacity derrick or mast is required as the maximum loads to which they may be subjected will be the weight of a joint or stand of pipe and the mud hose and swivel. The need for conventional massive crown and travelling blocks and Kelley joints is likewise eliminated.

Also, since the jacks are operated by hydraulic pressure, the power requirements for running and operating the drill string may be met by relatively small compact power units as compared with the engines required for more conventional rotary drilling rigs. The whole rig may be skid-mounted for easy overland transportation by trucks and is readily adaptable for use in marine drilling.

The apparatus herein described may also be used for running casing, when required, by appropriate changes in the dimensions of the pipe-gripping elements to accommodate the different casing dimensions.

The entire system for drilling and handling pipe is designed for operation by a set of remote automated controls; requires an absolute minimum of manual labor; and operates with a maximum degree of speed and efficiency.

The numerous other advantages of the apparatus herein disclosed will be readily apparent to those skilled in the art. It will be understood that numerous changes and modifications may be made in the details of the illustrative embodiment within the scope of the appended claims but without departing from the spirit of this invention.

I claim:

1. A well drilling snubber, comprising:
   a. a supporting base;
   b. a stationary lower snubbing member mounted on said base;
   c. an upper snubbing member disposed on said base above said lower snubbing member for rotation and vertical reciprocation relative to the latter;
   d. fluid pressure-operated means on said base for reciprocating and rotating said upper snubbing member;
   e. each of said snubbing members including:
      i. a tubular body having a vertical through-bore to receive a pipe;
      ii. a frusto-conical bushing mounted in said bore for limited angular movement therein relative to said body;
      iii. a set of pipe-gripping wedges mounted in said bushing for reciprocative movement into and out of pipe-gripping position;
      iv. fluid pressure-actuated means for reciprocating said wedges;
      v. a torsion-transmitting member mounted to said bushing below said wedges; and